Review of Visualization Techniques For Transportation Planning

(Approved March 2, 2009)

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Introduction

With the passage of Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) in 2005, came an increased focus on improving public involvement. Public involvement in transportation planning and project development moved to a point where agencies were doing a good job of bringing the public and interested parties into the planning and projects development process, but some felt there was a lack of understanding of what planning was recommending and how projects would actually look.

At the same time, technology was coming up with easier and better methods which could graphically portray an image of the proposed activity. Federal Highway Administration (FHWA) called this method visualization. Webster's defines visualization as "formation of mental visual images, or the act or process of interpreting in visual terms or of putting into visible form." Transportation has a planning and project development phase. Each phase involves the public in a different way through the process. For many years project development engineers have used visualization in the form of simulations, drawings, and even computer animation to generate images which give the public a better understanding of what will be constructed and how projects might look and operate. Planning, on the other hand, is more difficult when it comes to providing a description of what the goals, policies, and recommendations will actually do. The FHWA website gives a good example of the problems many transportation plans run into in their effort to inform the public. They state, “Planning documents are often spreadsheets that are difficult to read, populated with acronyms and abbreviations that must be deciphered or plans that are filled with dense narrative describing a process, procedure, policy or proposal.” [i]

The new focus from Congress in the passing of SAFETEA-LU was to ensure that transportation plans developed implementing SAFETEA-LU would be done using visualizations techniques. The staff, Technical Advisory Committee, and Policy Board of the Bannock Transportation Planning Organization feel we have done a good job including better ways of explaining transportation plans for the area, but to be sure we were doing the best job possible, we developed this study.

The purpose of this document is to provide a review on how BTPO currently conducts public involvement, document preparation, and website design and determine if visualization techniques can improve the understanding of the information being presented.

Visualization and Public Participation

Visualization is techniques that assist the public in understanding proposed concepts, projects, and programs. A description of a project or a point on a map can provide some information but a picture showing the proposed or recommended change can give the viewer a better understanding of the proposed project. In transportation planning, the concepts like capacity and level of service, or delay are an abstract ranking system. Professional engineers and planners understand these quantitative measures and use them

to analyze and find solutions to traffic problems. These terms have little meaning to the public. Using visualization techniques like 3-D simulation, video, or photos can better convert the quantitative measures into a format the drivers can relate to and experience.

As with any project or activity there are trade-offs in ability to communicate ideas and the cost to communicate those ideas. A "B" movie and a "block buster" might use the same special effect but how it comes across to the public is different. Transportation planning is similar in that you can show a map with the location of problem areas and description of problems or create a 3-D video showing the problem. Table 1 shows the categories of data we typically use in the development of a long-range plan along with some possible techniques for adding the category.

Project development public involvement is different from planning public involvement. In project development the objective is to give the public a full picture of how the improvements will look and operate in a specific situation. In planning, the alternatives show more of a concept. For example, in the case of a road widening project development visualization would use actual drawings and real world measurements to show the proposed plan. For the same project in planning, the visualization would only provide the types of features which might be included in the project. In an example on the Federal Lands website, the same project is shown two different ways. [ii] Figure 1 shows the eye view to be used in the design phase of the project which would provide the drivers and landowners an idea of how the road would look when built.

Figure 1: Eye View

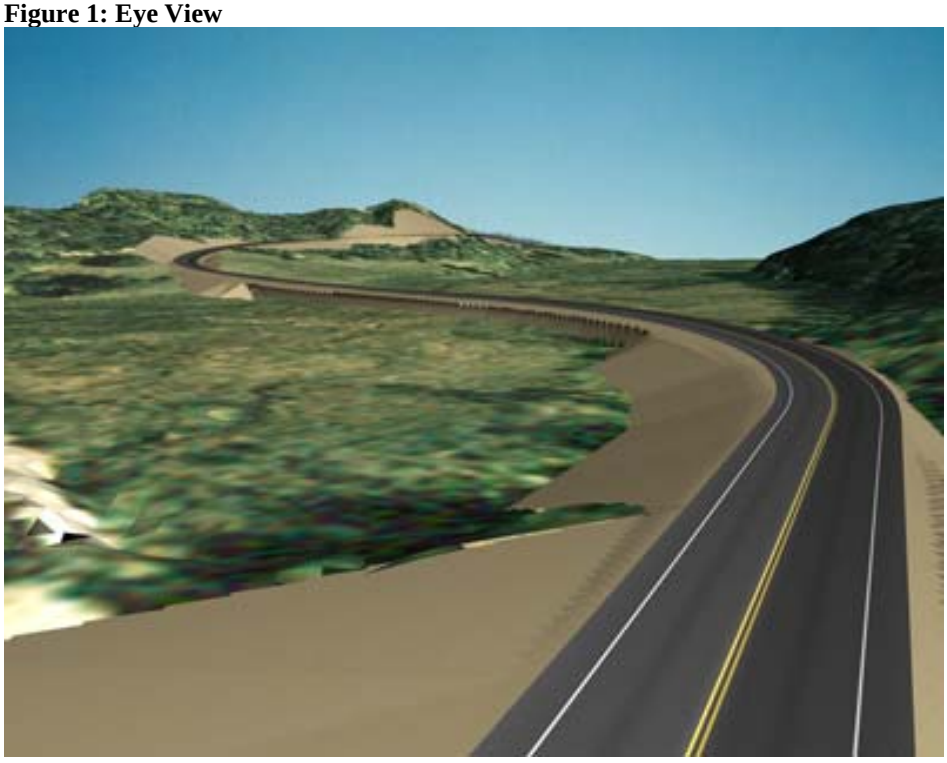

Figure 2 shows the eagle eye (aerial) view of the same project. This photo shows a good overall concept of where the project is going without providing design detail shown in Figure 1. While the eagle eye photo comes from design drawings a photo manipulation could be done on a planning scale.

Figure 2 Eagle Eye View

Visualization is a tool agencies like BTPO can use to increase the effectiveness of public involvement activities. An effective public involvement campaign is one that informs, educates and involves the public. This is the ultimate goal of public involvement and the main goal of this paper is to identify those visualization techniques which would help BTPO develop an effective public involvement.

Table 1 Types of Visualization by Category

Category	**Description of Category**	**Subcategories**	**Possible Techniques**
Traffic and Demographic Data	Show the various factors that affect the operating conditions of the road. The categories use used to determine performance measures. These categories also show needs of the system when performance measures are applied.	• Traffic Counts • Traffic Flow • Level of Service (delay) • Volume to Capacity ratio • Crashes • Population estimates • Employment estimates	• Databases • Maps • Web based interactive mapping • Charts
Design Principles	These are the principles used in the development of alternatives to solve problems identified in various performance measures.	• Street Design • Transit Compatibility • Functional Classification • Bike/Ped Design	• Drawings (CAD) • Drawings (artistic) • 3D modeling • Illustrative photos or images • Models with fly though capabilities • Charts or tables showing characteristics • Photo manipulation
Concepts	The most comprehensive category. The concepts are those long-term design based solutions to problems identified in the performance measures of community goals.	• Access management • Walk ability • Alternative street design • Land Use Design • Impact of development with various codes • ITS	• Illustrative photos or images • 3D Modeling (Community-Vis) that show changes to land use over time. • Drawings (CAD) • Drawings (artistic)
Other	This category is for miscellaneous type activities such as vision and how future projects might look or affect the surrounding area.	• Vision for future • Future project descriptions • TIP	• Maps • Illustrative photos or images • Drawings (CAD) • Drawings (artistic) • Web based interactive mapping • Tables

Review of Current Practices

The review of current practices will not be a statistically valid survey, rather only a search of the literature on what other agencies do for public involvement using visualization techniques. This review is limited to activities related to transportation planning. There are some crossovers in planning activities and project development. In those cases, we will describe the activities most used by planners. The choice of visualization methods are affected by specific purpose. Visualization methods for a public involvement event might be different than for a written plan or website. The purpose of this section is to describe the methods used by other agencies which have been identified as effective methods of visualization. Tables and charts, artistic concepts, photo image composites, illustrative images, video, computer animations, Geographic Information Systems (GIS) maps, and websites are the seven major areas which contain the type of activities used.

Tables and Charts

Many agencies use tables and charts within various planning documents to simplify or explain complicated procedures and proposals. Agencies use tables mostly to present data on project lists.

Flowcharts explain transportation procedures and timelines for these processes. The flow chart, rather than a narrative, can much more readily explain the points when concurrent processes intercept during a transportation planning process. It is hard to capture all the ways charts and tables are used in transportation planning documents and websites. A search of recognized plans and website charts and tables has these common traits:

- Simple language without acronyms or abbreviations;
- Colors to separate ideas of concepts;
- Titles that capture what the chart is trying to accomplish; and
- Clean presentation without clutter.

Artistic Concept

Artistic concepts are representative of what the final product might look like. These drawings (see Figure 3) are normally developed in the concept phase of a project. Artistic concepts are mostly used to show overall development plans such as a corridors, specific developments, site layouts, or transit facilities. These types of drawings are good at portraying a concept, but in some cases, when the final result is different than the concept, the public can be confused or disappointed in the process. Care must be used when using this type of visualization strategy to bring it back to the public when designs are more finalized.

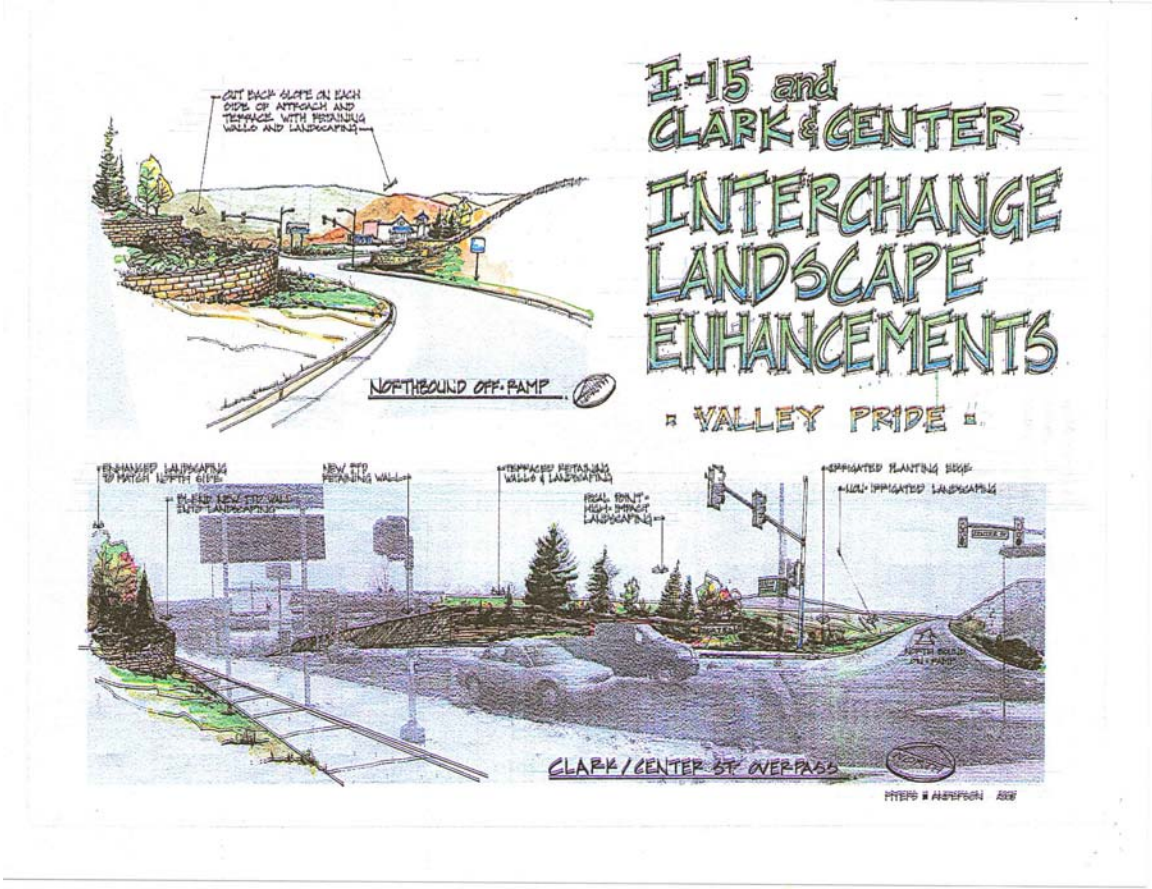

Figure 3: Artistic Concept for Interchange improvement

Photo Image Composite

Photo image composites are a digital image of a specific area or project. It is manipulated using software to show what the improvements might look like. This is different than Figure 1 where the changes shown for project development and are not usually built to scale. Figure 1 is based on information which could be used to develop construction drawings.

Photo images are a good way of presenting concepts and design plans without completing detailed survey work: what the current two lane road would look like when widened to four; how will the sidewalk or bicycle plan look along the road; and what the bridge over the river would look like. Figure 4 and 5 show a project conducted by CH2M Hill for the Idaho Transportation Department on US 30. These photos show a Photoshop altered photo showing the proposed improvements.

Most agencies use this type of visualization in development of master plans, corridor plans, or plans for specific improvements.

Figure 4: Existing Conditions US 30 from CH2M Hill Study

Figure 5: Proposed Improvements on US 30 from CH2M Hill Study

Illustrative Images

Illustrative images are not like photo images which have not been modified. These images are, as the name implies, used to illustrate a point. Figure 6 and 7 are from the BTPO pedestrian planning process and both use photos to illustrate problems. In the case of Figure 6 or best practices as in case of Figure 7. Illustrative images are a very commonly used visualization techniques in planning. The use ranges from visual preference surveys in land use or roadway design as a way of quickly showing what a specific concept or recommendation looks like in another setting.

This type of visualization is common in transportation planning. Many times photos of traffic are used to show what a specific level of service would look like to a driver or in other cases, what a specific treatment looks like in other areas. Roundabouts are an example of where agencies have used photos of existing roundabouts to show the public what they are.

The 2D and not case specific are two limitations of illustrative images. The 2D nature of the images still requires the viewer to imagine the area in 3D. The trade-off is the ability to see the proposed plan with low cost. In many cases, the illustrative images are not specific to the project in question. This is okay for a long-range plan but not as desirable for a specific corridor. The viewer has problems placing the image in the place of existing conditions.

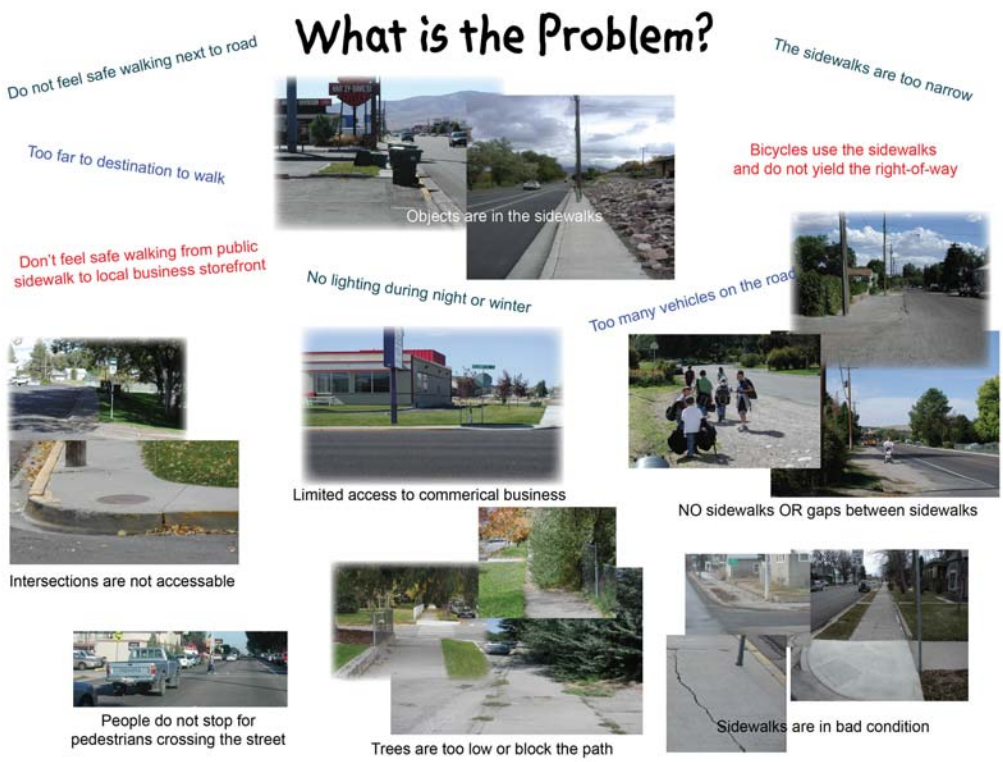

Figure 6: Problem Pedestrian Areas

Figure 7: Illustrative Image showing how to accommodate ADA Standard sidewalk

Video

Most video applications in transportation are related to construction or a computer animation. There are cases where videos are used to demonstrate a specific situation. One agency used a video to show congestion on a specific section. They then modified the video to show the improvements. This type of video overlay is limited due to the single view required and the effort to complete. Videos have also been used like illustrative images to show what a design or area would look like or operate. Roundabouts are another good example where video was used to show the operation of a roundabout. Some of the main benefits of video are the ability to capture existing conditions and changes over time. Video is a great a visualization tool but limited to public meetings or website applications.

Computer Animation

In the last five years, this area has changed the most. Project development is the main use for computer animation but it can take many forms. With the development of GIS systems, planning applications are benefitting from computer animation in more and more areas. Operations, fly over, and land use are the most common computer animations.

Viewing the operations of an intersection has improved with software like CORSIM, VISSIM, or TransModeler. These software packages use traffic signal information to show the operation of a specific signal or corridor. Most have 3D versions showing vehicles and buildings for an aerial shot. These types of models are useful in planning to show the projected Level of Service (LOS) and options to solve the problem.

Fly over modeling uses computer animation to show what a route or roadway would look like at current condition and then with improvements. This type of animation is primarily for project development, but it has been used for planning activities especially with corridor plans.

This area of computer animation has received the most improvements in recent years. Software like Community Viz and others take information from GIS packages and allow the user to see what a specific development would look like over time. These packages also have features which allow you to drive down streets to get a sense of the community. This ability to not only show land use, but also the transportation facilities is a good way to visualize the planned activity. Like in video, public meetings and web-based applications are most appropriate for this type of visualization.

Even with the advances in technology, computer animation is very labor intensive and requires some level of expertise to build the scenes required for the fly over or drive through. In many cases, the animation also requires very expensive computer equipment and software.

Geographic Information Systems (GIS) maps

GIS and Computer Aid Design (CAD) software is the most used visualization tool. Every agency has some CAD or GIS system which represents their community's roads. GIS technology has advanced to a point where most urban area GIS systems have many layers showing everything from the aerial coverage, location of buildings, water features, hazard areas, and topography.

In transportation planning, GIS and CAD display the results of travel demand forecasting. These forecasting models can show graphically the location of congested and problem areas. The combination of forecasting and GIS graphics also allow for comparison of existing conditions to future conditions.

GIS has the ability to show the location of planned improvements and programs that make it a great tool for public involvement and visualization. Maps have versatility for visualization. They can be displayed at meetings, on the web, or taken home for future study. This is the one visualization tool people can interact with and provide their input to a given situation. GIS layers combined with CAD drawings can be used to explain critical questions like how a project would affect property. The accuracy of the GIS system allows this to occur at the planning level.

The other advantage of GIS is the cost of the software and data have decreased over the years. Most agencies can achieve a level of accuracy with little cost. BTPO has many years experience using this technology and it is the backbone of most of our visualization materials. Working with other agencies in our community, we have built a very accurate system that allows us to display maps of transportation and demographic data.

The biggest change over the last few years in GIS is the ability to display the GIS system on a website. Prior to this, only desktop viewing was possible. This was good for the analysis, but not as good for public involvement. New web hosted GIS system allow the public to interact and change the maps to get data of specific interest. In one application all the proposed projects are located and with one click all other data including photos, project cost and status are visible. Currently, only large transportation planning agencies are using this technology. The City of Pocatello has an existing web hosted GIS system.

Websites

Federal Highway Administration rules for Metropolitan Planning Organization require the long range plan to be made available electronically on the World Wide Web. Web sites are a great place to make publications and information available. Websites also provide a transparency in the planning process. For visualization, however, the use has been limited to the display of meeting materials and other public information. Other agencies have been using website on a twenty–four hour information base. The web contains all the proposed projects, plans, and videos for viewing. Combined with public involvement these new websites are assisting in bringing more people to the table to provide the material in a format where most people are comfortable with. Those agencies that use their website as a visualization tool are growing and the information they are providing is amazing.

One benefit of using a website for visualization is they are required and somewhat low cost to maintain and use. Websites require some expertise or consultant assistance to maintain and updated if they are to be effective.

Alternatives

Alternative visualization techniques were developed using the Technical Advisory Committee. Over a period of several months, different techniques were showcased and discussed. Each alternative was evaluated by ease of use, applicability of use in transportation planning, effectiveness of the technique, BTPO existing capabilities, ability to develop capabilities, local consultant's capabilities, and cost.

Current Visualization Techniques

Traffic and demographic data, design principles, concepts, and other are the four categories used by BTPO (see Table 2). The existing method used by BTPO in each of the four areas will be described. This is intended to provide an overview of how visualization is conducted in our area.

Table 2: Categories of Data BTPO provides to the Public.

Traffic and Demographic Date	Design Principles	Concepts	Other
• Traffic Counts • Traffic Flow • Level of Service (delay) • Volume to Capacity ratio • Crashes • Population estimates • Employment estimates	• Street Design • Transit Compatibility • Functional Classification • Bike/Pedestrian Design	• Access management • Walk ability • Alternative street design • Land Use Design • Impact of development with various codes • ITS	• Vision for future • Future project descriptions • TIP

Traffic and Demographic Data

Maps and database tables are the two current methods used. With the exception of traffic counts, all the data is provided on maps at public meetings or in documents. BTPO does not post, on a consistent basis, maps on the website.

Design Principles

Functional Classification is shown on a state approved map. The other information like proposed Right-of-Way (ROW) and street design recommendations are shown using CAD drawings. The drawings provide a cross section view of the proposed recommendation. Figure 8 is an example of the type of CAD drawing used in previous studies to

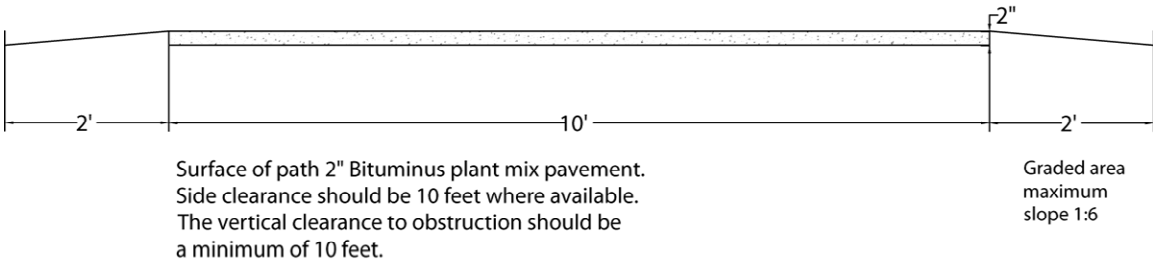

Figure 8: Bicycle Path Cross Section

Concepts

These last two areas are the most difficult to describe to the public in a visual way. BTPO has used all the techniques to describe the transportation concepts, such as walkability, new urbanism, transit-orientated development, and others. Mostly, we rely on text to provide the description.

Evaluated Alternatives

For each of the categories the Technical Advisory Committee identified alternatives to the existing methods of visualization. Each alternative will be described on what to achieve and our ability. Table 3 provides a summary of the data.

Traffic and Demographic Data

Most agencies we investigated used tables or maps posted to their website. Some of the most interesting ones used GIS to combine the databases and maps into interactive maps. These web maps provide specific information like traffic counts, LOS, and others but through a web map. These maps allow you to search for your data, zoom in, and get additional information about the specific point of interest.

Design Principles, Concepts and Other

We combined the last three due to the overlap in techniques. Artistic and photo images composites are the most common visualization tools used by planning agencies for plans. These techniques work well in documents or on a website to explain the principle in question. To a limited extent, illustrative images are used in planning efforts. These are less effective due to the lack of familiarity to the area where the photo was taken and the need to visualize the image in use in your community.

3D simulations are used in public meeting settings. These techniques can be very good at allowing the public to see the problems and what the proposed solution would look like. Simulations and video are also best used in a specific case such as corridor studies.

Table 3: Alternative Worksheet

Type	Visualization Alternatives	Cost*	Effectiveness	Ability to Accomplish
Traffic and Demographic Data	Maps and Databases**	Included in TransCAD License ($5,000)	Moderate	Basic maps are within current staffs capability
	Web based GIS	Software Costs ($4000).	Moderate to very in providing general public information	With capability with training
Design Principles, Concepts and Other	CAD Drawings**	AutoCAD maintenance ($1000)	OK effectiveness the drawings a primitive	Only very limited drawings, ability to add detail in limited
	Illustrative Images **	Current equipment no additional cost	Somewhat effective if have correct illustrative image	Limited database of images
	Artistic Images	N/A	Effective	Current staff can not do artistic images
	Photo Image Composite	Have software no cost	Effective to very effective	Would need additional training for staff to complete.
	3D Simulation	Software cost ($3000)	Can be effective in meetings	Have equipment but would need to receive training

***Annual estimate cost for BTPO to perform the task additional**
****Existing Techniques**

Evaluation of Alternatives

For each of the alternatives staff evaluated the alternative with the following criteria:

- Ease of use
- Applicability of use in transportation planning
- Effectiveness of the technique
- Does BTPO have the existing capabilities or can we develop the capabilities?
- Availability through local consultants
- Cost

Recommendations

The purpose of this study is to determine methods to use in our visualization process and to use this information to build capacity with existing staff or find consultants to assist in specific aspects. Not every area identified above will be covered, only those areas where recommendations were made.

Recommendation 1: Make transportation data available on website

Recommendation: To use interactive web based GIS system to make transportation data such as traffic counts, capacity, and delay available on the web. Recommendation would also evaluate the effectiveness after the long range plan is completed.
Action: Purchase two copies of Maptitude for the Web (one for use and one for web site host).
Cost: Cost for two copies of Maptitude for $4,000 per year. Cost would need to be added to the modeling budget.

Recommendation 2: Develop ability to complete 3D Simulations

Recommendations: Enable the agency to show the results of the signal coordination system on 3D and to develop a land use based 3D visualization for land use alternatives.
Action: BTPO owns the software but lacks training to be able to complete the required tasks. Get training for Synchro and Community Vis software.
Cost: Total staff training cost is $5,000 and $3,000 is committed to training in the project budget. The additional amount would come from existing training budget.

Recommendation 3: Develop ability to do photo composites

Recommendations: Have staff use existing Photoshop, AutoCAD software to alter digital images to show the recommended changes and concepts
Action: BTPO owns the software and has taken some Photoshop classes but could use additional training to be able to complete the required tasks. Continue training in Photoshop.
Cost: Most classes cost around $300 each.

Recommendation 4: Build an illustrated image database

Recommendations: Use on-line and develop a database for illustrative images for use in planning studies.
Action: Encourage staff to take digital photos of identified areas in locations they visit for personal or professional reasons. Provide introduction to digital photography classes to staff if needed.
Cost: Cost for these trainings are around $300 each and will be included in annual training budget.

Recommendation 5: Identify artists who can develop artistic concepts

Recommendations: Identify and catalog artists who can draw various transportation and land use scenarios for use. This database will be used when it

is determined that the best alternative to show a specific concept is an artistic concept.
Action: Start gathering contact information for individuals who can do this type of work.
Cost: Costs vary but average around $1,000 to $3,000 per drawing.

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[i] Federal Highway Administration, (2009). Planning. Retrieved January 27, 2009, from Web site: http://www.fhwa.dot.gov/planning/vip/narratives.htm

[ii] Federal Lands Administration (2009), Retrieved February 4, 2009, from web site http://www.efl.fhwa.dot.gov/manuals/dv/manual/chapter5/cs_cuba_lacueva_model.aspx